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Research article

Optimal level of cowpea (*Vigna unguiculata*) pods in feed of growing rabbit (*Oryctolagus cuniculus*): Digestibility study and growth performances

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Abstract

An experiment was carried out to evaluate the digestibility and to define the optimal rate of cowpea pods in growing rabbits' diet. In total, 80 weaned rabbits (six week old) were divided into 20 repetitions of 4 rabbits each. The 5 repetitions of each dietary treatment were randomly divided into 5 groups. During eight weeks, rabbits were fed with 4 balanced diets containing 0% (F0, control), 5% (F5), 10% (F10), and 15% (F15) of cowpea pods. Per treatment, 6 rabbits were sampled for the digestibility study at the end of the growth experiment period. The daily feed intake was significantly high in rabbits fed F10 and F15 ($P<0.05$). The digestibility of dry matter, organic matter and crude protein decreased in F10 and F15 diets compared to F0 and F5 but the difference was not significant ($P>0.05$). At the age of 14 weeks, the average live weight of rabbits was 1865.37±209.97 g, 1644.33±11.07 g, 1596.88±58.52 g and 1515.00±140.4 g in F10, F15, F0 and F5 respectively. Mortality rate of rabbits was lower in F0 than in F15. Compared to control diet (F0), the feed conversion ratio, feeding cost and economic feed efficiency were better in rabbits fed F10 diet but not significant ($P>0.05$). The results demonstrated that up to 10% of cowpea pods can be included efficiently in growing rabbits' diet.

Keywords: Cowpea pod; digestibility; growth performances; rabbit

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Introduction

Rabbit production exemplifies the vast possibilities for increasing meat production in the most poverty stricken parts of the world. This is due to its high fecundity, fast growth rate, short generation interval and low feed cost (Etchu et al., 2013). Apart from their high rate of reproduction, these species are characterized by, the best efficiency of nutrient transformation into high quality animal protein (Aboh et al., 2013). Rabbit breeding is in full expansion in Benin. From 2003 to 2005, the number of the rabbit breeders increased from 300 to 700, in South of Benin (Fagbohoun, 2006). This production provides 240 tons of rabbit meats per year and occupies approximately 7000 persons in Benin (Fagbohoun, 2006). In spite of this big expansion, a major constraint for profitable rabbit production for poor farmers in southern Benin is the annually feed availability (Aboh et al., 2013). Specifically, the availability of forages, main sources of fibre is low in peri-urban areas, and farmers have difficulties to provide rabbits with grass. The processing of complete diets with optimal level of fibres is therefore suitable to efficiently feed rabbits (Houndonougbo et al., 2012).

Of all analyzed inshore countries, Benin shines by the tendency that the production of the cowpea takes. In

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addition to a fast evolution of national production, we assist more and more to a light modification of the culture zones. In spite of the increase of cowpea production in different regions of Benin (Soulé, 2002), the management of cowpea pod result in its burning in the field. Houndonougbo (2014) analyzed two varieties of the cowpea pods and reported that they contained 91.6 and 88.7% of dry mater, 4.49 and 5.34% of crude proteins, 1.90 and 1.93 of fat and, 52.1 and 49.6 of crude fibres. They can be therefore included in rabbits' balanced diets.

The objective of this study was to contribute to the valorization of cowpea pods fibres in growing rabbits feeding by evaluating its digestibility and optimal level in their diets.

Materials and Methods

Growth performances study

The experiment was arranged in a randomized complete block design with 4 diets and 5 repetitions. Eighty weaned rabbits, of average 45 days old, with initial average weight of 631.82 g were used during 56 days feeding trial. Rabbits were divided in 5 groups of 16 rabbits each, after balancing the weight. At the beginning of the experiment, similar (P>0.05) average live body weights of rabbits were recorded in F0 (640.0 g), A5 (635.0 g), F10 (627.5 g), and F15 (625.0 g) dietary treatments. Each group had 4 cages or repetition of 4 rabbits each. Four rabbits of a repetition were housed in a cage ($75\times45\times33cm^3$). Feed and clean water were supplied *ad libitum* throughout the experiment.

Four experimental diets used contained 0% (F0, control diet), 5% (F5), 10% (F10), and 15% (F15) of cowpea pods (Table 1). Feeds were in meal. They had similar digestible energy and crude proteins (Table 2). The experiment took eight weeks.

Digestibility study

Twenty-four rabbits, weighing on average 1779.17 ± 50.9 g were divided into 4 groups assigned to the four experimental diets F0, F5, F10, and F15. Rabbits were housed in individual digestibility cage for total faeces collection. Rabbits were fasted for 24 hours to empty their digest tract. During the fast, water and vitamin was delivered as anti-stress. Daily, 100 g of feed and 500 ml of water were given to each rabbit. Refusals and faeces were weighed daily per rabbit during 5 days. Proximate chemical composition of the experimental diets and faecal samples was determined to calculate apparent digestibility of dry matter (dDM), organic matter (dOM) and crude protein (dCP) as following:

$$dDM (\%) = \frac{\text{DM intake} - \text{DM excreted in faeces}}{\text{DM intake}} \times 100$$

$$dOM (\%) = \frac{\text{OM intake} - \text{OM excreted in faeces}}{\text{OM intake}} \times 100$$

$$dCP (\%) = \frac{\text{CP intake} - \text{CP excreted in faeces}}{\text{CP intake}} \times 100$$

Chemical analyses

Chemical analysis was carried out on cowpea pods, feed and faeces: Dry matter (24 h at 105°C), ash (6 h at 550°C) and nitrogen (N by Kjeldahl method) were determined and crude protein (CP) was estimated as following: CP = N x 6.25.

Table 1: Composition in ingredients and prices of rabbits' feeds as formulated and fed

Ingrédients (%)	F0	F5	F10	F15
Maize grains	22	31	31	34
Wheat bran	28	15	10	3
Soybean meal	9	12	14	17
Cotton meal	7	7	7	7
Palm-kernel meal	30	27	25	21
Oyster shell	3	1.7	1.7	1.7
Lysine	0.1	0.1	0.1	0.1
Methionine	0.1	0.1	0.1	0.1
Bi-calcium Phosphate	1	1	1	1
Salt (NaCl)	0.3	0.3	0.3	0.3
Premix[1]	0.2	0	0	0
Iron Sulphate	0.1	0.02	0.02	0.02
Cowpea pods	0	5	10	15
Feed price (FCFA/kg)[2]	213.79	210.85	210.85	210.85

[1]Premix contained per kg - Vitamins: A 4000000 UI, D3 800000 UI, E 2000 mg, K 800 mg, B1 600 mg, B2 2000 mg, niacin 3600 mg, B6 1200 mg, B12 4mg, choline chloride 80000 mg; Minerals: Cu 8000 mg, Mn 64000 mg, Zn 40 000 mg, Fe 32000 mg, and Se 160 mg ; [2]1€ = 655.9 FCFA

Table 2: Chemical composition of growing rabbits' diets as formulated and fed

Chemical composition	F0	F5	F10	F15
Dry matter (%)	89.1	88.5	88.7	88.9
Crude fibre (%)	9.25	10.45	12.3	13.8
Crude fat (%)	7.46	6.95	6.55	5.91
Digestible energy (kcal/kg)	2643	2667	2568	2502
Crude protein (%)	17.57	17.49	17.57	17.74
Lysine (%)	0.82	0.83	0.85	0.88
Methionine (%)	0.38	0.38	0.38	0.38
Sulfur Amino acid (%)	0.71	0.7	0.69	0.69
Ca (%)	1.51	0.99	0.98	0.97
P (%)	0.93	0.78	0.72	0.64
Na (%)	0.16	0.14	0.14	0.14

Statistical analysis

Data were analyzed using general linear model (GLM) with the help of SAS (version 9.2). Performances of rabbits were compared using each cage of four rabbits as repetition.

Thus, analyses were performed according to the model as follows:

$$Yi = \mu + Fi + \varepsilon i,$$

Where Yi is the observation for dependent variables; μ is the general mean; Fi is the fixed effect of the feed; εi is the residual error.

Mean values are presented in table with their standard deviation. The significant effect of feeds on variables was reported when P–value < 0.05.

Results

Feed intake of growing rabbits

During the experiment, the daily feed intake of rabbits fed with the four diets (Fig. 1) was significantly different (P<0.05). On average, daily feed intake was 70.64±5.80 g/d, 69.99±5.15 g/d, 59.58 ±5.26 g/d and 59.14 ±5.70 g/d respectively in rabbits fed F15, F10, F5 and F0. In general the feed intake decreased when the level of cowpea pod and crude fibre (Table 2) is low in the diet.

Digestibility of diet

The apparent digestibility of dry matter, organic matter and crude protein was slightly higher (P>0.05) in rabbits fed F5 and control diet (F0) but lower in F10 and F15 dietary treatment (Table 3).

Growth performance and feed efficiency

Rabbits fed F10 had the highest final live body weight (1865.37±209.97 g) (Fig. 2) and daily weight gain (22.11±3.83 g/d) (Table 4). However, statistically these growth performances were similar (P>0.05) between rabbits indicating the efficiency of cowpea pods-based diets in rabbit feeding. The lowest feed conversion ratio, feeding cost and economic feed efficiency were recorded in rabbits fed F10 diet (Table 4). But, these parameters were not significantly affected by the dietary treatment (P>0.05). Mortality rate was similar in all dietary treatment (P>0.05); but the lowest was in rabbits fed with control diet (Table 4). These result demonstrated that the incorporation of cowpea pod in growing rabbit feed did not affect significantly their mortality rate and growth.

Discussion

The cowpea pods were sun dried to ensure that feedstuff is at a suitable level of dry matter (90.2%). Aboh et al. (2013) and Houndonougbo et al. (2012) obtained also stabilized feedstuffs using the same drying method for pineapple peel and palm-press fibres respectively. In fact, the sun drying of cowpea pod would avoid the microbial attacks and the deterioration of the nutritional quality of that feedstuff. That method is therefore suitable in tropical regions. Also, the conservation by sun drying contributes to reduce the loss of that by-product and the prevention of environment pollution. The content of dry matter (90.2%), crude protein (9.02%), crude fat (1.9%), gross energy (4305 kcal per kg), ash (3.35%), crude fibre (49.62%) recorded from sundry cowpea pod in the present study indicated that it is a useful source of nutrients for rabbits.

There was a significant differences (P<0.05) in daily feed intake of rabbits between treatments. This might be due to the reduction of digestible energy with the increase of cowpea pod level. In addition, these results demonstrate the ability of rabbits to handle high amount of fibre in their diets to fulfill their nutrient needs. Gidenne and Bellier (2000), and Gidenne and Perez (2000) had reported that feed ingredients rich in fibre are particularly well digested by rabbits. Thus, experimental feeds based on cowpea pods are palatable than control diet for the rabbits.

The inclusion of cowpea pods in feed depressed the digestibility of dry matter, organic matter and crude protein compared to the control diet (Table 3). Inclusion of high level of fibre reduces the digestibility of diet (Kadi et al., 2012). Dry matter digestibility obtained is higher than 62 to 67% recorded by Aboh et

Table 3: Apparent digestibility in rabbits fed with cowpea pods based diets

Parameters	F0	F5	F10	F15	Pr
dDM (%)	83.57±2.41	81.69±0.53	80.59±0.57	78.78±2.38	0.29
dOM (%)	83.13±0.32	84.50±1.69	81.47±1.34	82.14±0.67	0.57
dCP (%)	60.57±4.12	56.75±0.30	55.47±0.98	53.03±3.42	0.60

dDM: digestibility of dry matter, dOM: digestibility of organic matter, dCP: digestibility of crude protein, Pr : Probability.

Table 4: Daily weight gain (g), feed conversion ratio (g feed/g BWG), mortality rate (%), feeding cost (FCFA feed/kg BWG), and economic feed efficiency (FCFA BWG/FCFA feed) of growing rabbits fed cowpea pod-based diets

Parameters	F0	F5	F10	F15	Pr
DWG	17.08±1.20	15.72±2.56	22.11±3.83	18.20±0.08	0.795
FCR	3.53±0.42	3.88±0.77	3.26±0.15	3.88±0.24	0.317
MR	4.28±0.90	5.54±0.36	5.32±0.14	5.59±0.41	0.971
FC	754.28±95.60	818.75±160.07	687.88±29.20	818.25±48.46	0.310
EFE	2.30±0.12	2.12±0.06	2.55±0.37	2.08±0.18	0.749

DWG: Daily weight gain, FCR: Feed conversion ratio, MR: Mortality rate, FC: Feeding cost, EFE: Economic feed efficiency, Pr: Probability; BWG: Live body weight gain, Currency: 1€ = 655.9 FCFA.

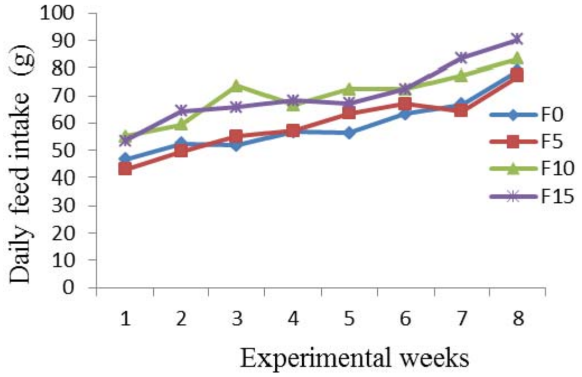

Fig. 1: Average daily feed intake of growing rabbits fed with cowpea pod based diets.

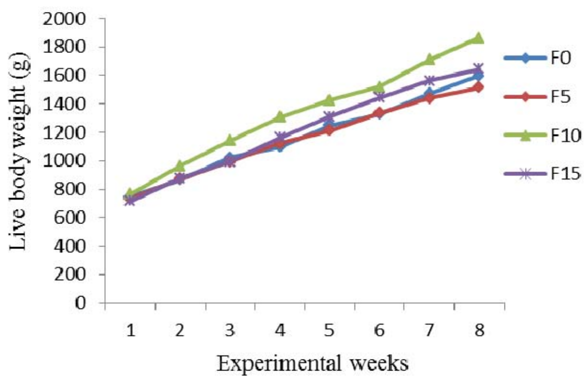

Fig. 2: Growth curves of rabbits fed cowpea pod diets.

al. (2013) with inclusion of pineapple peel in rabbit diet. Similarly, 63% was obtained by Etchu et al. (2013) with inclusion of groundnut (*Arachis hypogeae*) haulms in rabbit diet; but lower than 95% recorded by Adedeji et al. (2013) with *Leucaena Leucocephala* in rabbit diet. The decrease of organic matter and crude protein digestibility with the inclusion of high level of cowpea pods could be due to the presence of anti-nutritional factors; but, no analysis was done on anti-nutritional factors in cowpea pod. Agwunobi et al. (2002); Ndimantang et al. (2006) and Okereke (2012) reported that the presence of anti-nutritional factors ranging from phytates, oxalates, saponins and tannins may greatly reduce digestibility. Oxalates have been reported to form complexes with mineral particularly calcium thereby making them unavailable to the body, cause irritation of the gut and resulting in low feed intake, inhibit protein and energy utilization in broilers. Phytates impairs the utilization of protein and some minerals resulting in poor performance while tannins inhibit digestive enzymes and causes irritation of the gut (Hang and Preston, 2009; Hang and Binh, 2013). According to these authors, not only does oxalate interfere with calcium absorption in the digestive tract, it also limits nitrogen retention. Saponins form bonds with protein (Livingstone et al., 1977) and therefore could conceivably bind digestive enzymes.

Low mortality rates were recorded during the experiment. This result indicates that rabbits can consume, cowpea pods based-diet, without major risk of intoxication during the growth period. However, the results are in contrast with those of Houndonougbo et al. (2012) and Aboh et al. (2013) who did not recorded mortality during their experiments when using palm-press fibres and pineapple peel in growing rabbit feeding respectively.

The effect of cowpea pod in rabbit diet was not significant regarding their body weight gain; thus the growth of rabbits fed different levels of cowpea pod based diets was similar. It indicates the efficiency of that feedstuff in rabbit feeding. However, the average live-weight gain was better with 10% of cowpea pod inclusion. The final live body weight showed that F10 allowed better growth performance than control, F5 and F15 diet. The daily weight gain of the experimental rabbits (15.72g/d to 18.20 g/d) was lower than 19.7 to 23.1 g/day and 19 to 22 g/d recorded by Houndonougbo et al. (2012) and Kpodekon et al. (2009) respectively in Benin. Feed intake contributes to daily weight gain and final weight of rabbit. Thus, the low performance of rabbits fed F5 diet might be due to their low feed intake.

In addition to growth performance in rabbit fed F10 diet, feed conversion ratio, feed cost and economic feed efficiency were improved. The feed conversion ratios recorded in this experiment are similar with the average values reported by Kpodékon et al. (2009) with a conventional diet. They are also lower than 3.78 to 4.64 reported by Houndonougbo et al. (2012) in rabbit fed palm-press fibre (0-15%) based-diets; but, better than 7.8 to 8.2 recorded by Adeyemi et al. (2010) when using pineapple peel feed. The difference may be due to the nutrient unbalance mainly, the energy contents of diets.

Feed cost and economic feed efficiency was better in rabbits fed F10 diet (687.88±29.20 FCFA feed/kg body weight gain and 2.55±0.37 respectively). However, the feed cost (687.88 to 818.25 FCFA feed/kg body weight gain) was lower than 760 to 816 FCFA feed/kg body weight gain recorded by Houndonougbo et al. (2012) while the economic feed efficiency (2.08 to 2.55) was similar to 2.09 to 2.46 reported by these authors. These economic results can be explained by the feed price (213.79 FCFA/kg for control diet versus 210.85 FCFA/kg feed for experimental diet) that was higher than 189 to 191 FCFA/kg feed reported by Houndonougbo et al. (2012) in Benin.

Conclusion

The results demonstrated that cowpea pod level beyond 10% leads to increase feed intake and mortality rate but decrease growth performance. It could therefore be asserted that cowpea pod had adverse effects in growing rabbits when it is included beyond 10% in their feed.

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